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# **GIS FOR NATURAL RESOURCES MANAGERS**

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Community  
Partnerships for  
Sustainable  
Resource  
Management in  
Malawi

## GIS FOR NATURAL RESOURCES MANAGERS

An intermediate-level training course for  
District Environmental Officers in Malawi

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The Environmental Information System (EIS) Unit of Malawi's Environmental Affairs Department (EAD) in Lilongwe. The EIS provided GIS data generated during the implementation of the Public Lands Utilization Study (PLUS). The University of Arizona's Office of Arid Lands Studies (OALS) led this effort as principal contractors under the United States Agency for International Development's (USAID's) Malawi Environmental Monitoring Program (MEMP).

The International Food Policy Research Institute (IFPRI) in Washington DC provided GIS layers and demographic data collected during the household survey it conducted in 1997/98 in collaboration with Malawi's National Statistical Office (NSO).

USAID's Famine Early Warning System (FEWS) team in Lilongwe contributed valuable data, including time-series agricultural area, yield and production statistics for 154 Extension Planning Areas (EPA's).

The Danish International Aid Agency (DANIDA) provided the computer equipment and software the District Environmental Officers will be using to put their newly acquired mapping and GIS skills into practice.

## Acronyms and Abbreviations

<b>APATU</b>	Agricultural Policy Analysis Training Unit at the University of Malawi's Bunda Agricultural College, Lilongwe
<b>CBNRM</b>	Community Based Natural Resources Management
<b>COMPASS</b>	Community Partnerships for Sustainable Resources Management (USAID-funded CBNRM initiative)
<b>DANIDA</b>	Danish International Aid Agency
<b>EA</b>	(Census) Enumeration Area
<b>EAD</b>	Environmental Affairs Department
<b>EDO</b>	District Environmental Officer
<b>EIS</b>	Environmental Information System (Unit)
<b>EPA</b>	Extension Planning Area
<b>ESRI</b>	Earth Systems Research Institute of Redlands, California (producers of ArcExplorer, ArcView and ARC/INFO GIS software)
<b>FEWS</b>	Famine Early Warning System (USAID-funded initiative)
<b>GIS</b>	Geographical Information System
<b>GPS</b>	Global Positioning System
<b>IFPRI</b>	International Food Policy Research Institute
<b>LREP</b>	Land Resources Evaluation Project
<b>MEMP</b>	Malawi Environmental Monitoring Project
<b>NSO</b>	National Statistical Office
<b>OALS</b>	Office of Arid Lands Studies
<b>PA</b>	Protected Area
<b>PLUS</b>	Public Lands Utilization Study
<b>SOER</b>	State of the Environment Report
<b>STTA</b>	Short-Term Technical Assistant
<b>TA</b>	Traditional Area
<b>USAID</b>	United States Agency for International Development
<b>USGS</b>	United States Geological Survey
<b>UTM</b>	Universal Transverse Mercator (map projection and coordinate system used for the COMPASS Malawi GIS Database)





# **GIS for Natural Resource Managers in Malawi**

## **An Intermediate Level Training Course**

In November 2000, the United States Agency for International Development (USAID) funded a training course for some of Malawi's District Environmental Officers (EDO's). Conducted by staff from the Community Partnerships for Sustainable Resources Management (COMPASS) initiative, the 3-day training course introduced key natural resource management partners to the mapping sciences. Eight EDO's and two lecturers from Chancellor College attended the three-day course, which was entitled "Introductory Training in Applications of Geographic Information Systems and Remote Sensing". As part one of its planned three-part training program, this was COMPASS's first contribution to on-going efforts to strengthen spatial information management capacity in Malawi.

The short introductory course provided the participants with a solid background in the theory and concepts behind geographical information system (GIS) and remote sensing technology, but because of time and resource constraints, there was little opportunity for practical, hands-on instruction in specific mapping and GIS applications. Course evaluations clearly pointed towards a more practical, less theoretical approach for the second and third parts of the training program. Having gained a good understanding of the scope and complexity of mapping science technology, the participants also suggested future training courses last longer than three days and incorporate some field exercises as well as classroom sessions. With these suggestions in mind, COMPASS engaged David Craven as a short-term technical assistant (STTA) to design and conduct an intermediate-level GIS training course as Part 2 of the program. The course is entitled "GIS for Natural Resources Managers", and it was held at the Agricultural Policy Analysis Training Unit (APATU) of the University of Malawi's Bunda College of Agriculture from 9<sup>th</sup> – 20<sup>th</sup> September, 2002. Mr. Craven prepared this report as the official document of record for this activity.

In the main body of the report, Section 1 describes the objectives of the training program and the approach taken to meet those objectives. Section 2 outlines the contents and structure of the course, the techniques and procedures the participants learned, and the timetable for the lectures, hands-on exercises and field trips. Section 3 describes the training materials used, and in particular the contents of the "COMPASS GIS Resource Kit". Feedback obtained from the participants is discussed in Section 4, and recommendations for follow-up support are given in Section 5. Supplementary material attached to the main body of the report includes a list of participants, a detailed course schedule, and examples of maps produced by members of the class. Extracts from the COMPASS GIS Resource Kit are also attached. These include documents describing the contents and structure of a CD that was given to each member of the class and a list of useful Web addresses. The final attachment is a dictionary that describes the 24 layers of geographic data in the COMPASS Malawi GIS Database, a national dataset compiled from various sources and used extensively by the class for hands-on exercises and individual project work.

# 1. Training Course Objectives and Approach

The primary objective of the “GIS for Natural Resource Managers” training course was to give the participants, and especially the EDO’s, some practical skills in GIS and related technologies – skills that would help them do their day-to-day jobs more effectively and more efficiently. One of the EDOs’ main responsibilities is to coordinate production of bi-annual State of the Environment Reports (SOER’s), so we designed the course to give them the skills they would need to conduct spatial analyses and produce maps specifically for those reports. We introduced the trainees to basic computer mapping concepts and techniques ESRI’s ArcExplorer application. For more advanced applications the participants learned basic ArcView functions and procedures.

Several of the participants complained that training courses they had attended in the past left them with little to take back to their home offices that would help them in their daily work. To avoid falling into the same trap, we designed the course around technology that we knew the participants would have access to back in their respective district offices. All the participants confirmed they had received good quality computer equipment from the Danish International Development Agency (DANIDA) within the last 2 years, and that the equipment is in good working order. Some District Environmental Offices already have ArcExplorer and ArcView GIS software, but few have any suitable data they can analyze and produce maps with. To make sure all the participants have a complete set of resources to take home after the course, COMPASS gave each of them a copy of ArcExplorer and a 24-layer digital spatial database covering all of Malawi.

Learning how to do spatial analysis and computer mapping requires intensive and prolonged hands-on exposure to the equipment, software and database components of a GIS. Thus it was important that we engaged the trainees as active participants rather than as passive observers. Using Bunda’s APATU computer laboratory as the venue for the course allowed each of the 9 participants full-time use of his or her own computer work station; each participant received a copy of the COMPASS GIS Resource Kit (see Section 3); and each participant concluded the course by developing a mapping project focused on his or her home district. Using this approach kept all 9 participants actively engaged throughout the course, and meant that each individual was able to work at his or her own pace and explore environmental issues relevant to his or her particular district.

The trainer used several teaching methods to introduce new techniques and procedures and to reinforce the skills the participants were acquiring. For much of the time the class followed routines and procedures the trainer demonstrated using a laptop computer, a projector and a screen. On a number of occasions the trainer presented lectures and led class discussions on theoretical or conceptual aspects of computer mapping and GIS. The class made one full-day and two half-day trips to the field, ostensibly to learn how to operate Global Positioning System (GPS) receivers to collect field data, but also to visit sites of general interest to natural resource managers such as the Dzalanyama Forest Reserve, Lake Malawi’s Senga Bay and the dam and reservoir at Kamuzu. During the last 3 days of the course, the participants worked on individual projects with the trainer providing guidance and technical support on an as-needed basis. The approximate breakdown of time devoted to each approach was as follows:

Demonstration/Hands-on Exercises	5 days (46%)
Lectures/Class Discussions	1 day (9%)

Field Trips	2 days (18%)
Individual Projects	3 days (27%)
	-----
Total	11 days (100%)

The blend of hands-on exercises, lectures, discussions, field trips and individual projects worked well to develop the participants' skills, build their confidence and maintain their interest throughout what was a long and intensive training program.

## 2. Course Contents and Schedule

COMPASS designed the training schedule to be flexible so that it could be modified as the course progressed. This flexibility was necessary in that it allowed us to accommodate the varying needs and interests of individual trainees, different learning speeds, and frequent problems with hardware and software. We used a general course schedule for overall direction and guidance, and daily outlines and objectives to plan and direct day-to-day tasks and activities. The trainer produced and distributed the outlines and objectives at the start of each day so that participants could complete unfinished exercises, revisit complex routines and techniques, and explore new procedures or areas of interest. Attachment II shows the course schedule and the daily outlines and objectives for the two-week program.

For the first 3 days of the course, the students learned basic computer mapping concepts and techniques through a series of exercises with ArcExplorer. To make sure they would be able to install the program on return to their home offices, participants installed, removed and re-installed the program several times each. The trainer used data sets for the U.S.A., Malawi and other African countries to demonstrate the differences between geographic (spatial) and attribute (tabular) data. Participants became familiar with the different types of data files associated with ESRI shape files (shp, dbf, sbx, sbn and shx), learned about different types of data that can be used as themes (shape files, ARC/INFO coverages, images), and used ArcExplorer project files (aep) to organize and save their work. In addition to learning about the different elements of the ArcExplorer interface, participants became proficient in basic operations such as zooming in and out, using the *Identify* button to query feature attributes, changing the symbols used to represent map features, and classifying data based on the values stored in attribute fields.

By Day-4 all the participants had produced maps showing the countries of Africa, population distribution in the U.S.A., and population distribution, vegetation and land cover in Malawi. They had also begun to think analytically and were using simple query techniques to answer questions such as "which state in the U.S. has the smallest population?", "which district in Malawi is most densely populated?" and "what types of land cover are most closely associated with densely settled districts?" Even though ArcExplorer is quite weak from an analytical point of view, members of the class were already beginning to appreciate the potential of more powerful programs for overlaying, buffering and otherwise examining spatial relationships among geographic features and distributions.

Spending a few days learning basic computer mapping techniques with ArcExplorer served as a nice introduction to the more powerful but substantially more complicated

ArcView. Frustrated by ArcExplorer's limited functionality, class members quickly learned to appreciate being able to access, sort and edit attribute tables, select geographic features, create subsets of themes, perform simple overlay functions and calculate values in internal and external attribute fields. They also quickly recognized the importance of thinking ahead and planning their work to organize and keep track of the numerous components of which an ArcView project is normally comprised. Within a few days, most of the trainees were comfortable working with views, layouts, themes and tables, performing simple spatial analyses (e.g. *clip, buffer and select-by-theme*), and saving their work in ArcView project files (.apr).

By the end of the first week, all the participants had produced maps of Malawi's protected areas and land cover in 1991. They had also created a subset of the national data set and used it to produce maps of protected areas in the Southern Region of the country. The sub-setting exercise exposed the class to some common problems associated with digital spatial data sets. Because data layers had been obtained from a number of different sources, many of them did not register accurately, and clipping and intersecting layers frequently generated unexpected results complete with sliver polygons, holes and spaghetti! The class spent a good deal of time discussing these results and understanding what brought them about – time well-spent given the reality of working with digital spatial data of dubious or unknown quality.

During the second week the class completed a series of clipping, buffering, and overlaying exercises to reinforce the techniques learned during Week 1. In addition the participants spent a lot of time working with tables, editing, sorting, adding and calculating fields and records. In preparation for their individual projects, they made subsets of the GIS data by clipping the national shape files with the boundary for their respective districts. The class also began to use the Data Dictionary for the COMPASS Malawi GIS Database (Attachment VI) to learn how the database is organized and what attributes they might be interested in analyzing as part of individual project work.

Several of the participants had expressed interest in learning how to use a GPS receiver and how to transfer GPS coordinate data from the receiver into a GIS database. Instruction was provided during the field trips to Dzalanyama and Salima, and on the campus of Bunda College. The participants learned basic operating procedures such as how to save coordinates as waypoints, how to navigate to a waypoint, and how to switch between coordinate systems. Some members of the class learned more advanced techniques for importing GPS coordinate data to ArcView. These techniques included on-screen digitizing, data transfer and adding a database file (.dbf) as an event theme. The time available for this work was only sufficient to give participants a flavor of the potential of GPS technology. As collecting field data is an important part of the work of an EDO, a significant part of any follow-up training course should be devoted to working with GPS receivers and coordinate data.

The individual projects were probably the most important part of the training course. Participants devoted 2½ days to their projects, reinforcing what they had learned earlier in the course, revisiting concepts and procedures they were unsure of, and exploring new techniques for processing and analyzing spatial data and presenting spatial information. Whereas during the early part of the course participants had followed the trainers' instructions and followed on-screen demonstrations of command sequences and procedures, for the project work they were largely given free reign with only minimal

guidance from the instructor. Intended more to stimulate thinking and generate ideas than to provide step-by-step instructions, the written guidelines for the project work are presented in the text box below.

The outputs participants produced from their projects are very impressive. Examples are presented in Attachment III. Whilst some of the EDOs were content to compile simple descriptive maps for their districts from individual layers of data, showing, for example, the location and extent of protected areas, population distribution, or land cover, several explored complex spatial relationships among different physical and human characteristics of the landscape. Prompted by suggestions given in the project instructions, a number of participants mapped changes in forest and other classes of land cover between 1973 and 1991. Others explored accessibility to protected areas both as a threat to the protected resources and as an opportunity for promoting eco-tourism. They defined accessibility in terms of proximity to major centers of population, roads, railroads and air fields. One participant identified the areas most suitable for growing maize in Machinga District. His suitability criteria included temperature and rainfall characteristics and existing land use patterns. Several trainees were concerned about water pollution. They identified the lakes and rivers most at risk based on proximity to densely populated areas and intensively farmed land, especially in tobacco- and maize-growing areas. Another class member produced maps showing the distribution of recipients of COMPASS grants. These maps are currently being used on the COMPASS web site where browsers can point-and-click to get detailed information about the activities being funded under our grant program.

### **Individual Spatial Analysis and Mapping Projects**

Compile and print 4 or 5 maps for the geographic area of your choice. The geographic area you choose should be a single region or district of Malawi. The maps should illustrate some environmental or natural resources management issues you feel are significant in your region or district. Examples might include maps showing the following:

- Population pressure threatening protected areas due to close proximity to major settlements, roads or airports.
- Opportunities for eco-tourism in protected areas due to close proximity to major settlements, roads or airports.
- Threats to water quality from pollution and excessive soil erosion caused by intensive agricultural activity along the banks of rivers and streams.
- Depletion of forest resources between 1973 and 1991.
- Importance of good forest cover to protect water sources upstream of major population centres.
- The extent of forest cover in National Parks and Forest Reserves in 1991.

## **3. Training Materials – The COMPASS GIS Resource Kit**

The participants in the training course each received a COMPASS GIS Resource Kit. The kit is comprised of a loose-leaf binder of documents and a CD containing software, GIS data and electronic versions of the documents in the binder. Three of the documents from the resource kit are included with this report as attachments. Those documents are:

Attachment IV. Contents and Structure of the GIS for Natural Resource Managers CD

In addition to these documents, the binder contains a copy of the ESRI ArcExplorer User Manual, a number of papers describing GIS applications and case studies addressing a range of environmental and natural resources management issues, and several maps included as examples of outputs from GIS applications for natural resource managers. The main purpose of distributing the resource kit was to give the participants all the materials they would need to establish a basic mapping and GIS capacity at their respective district offices. These include GIS software (ArcExplorer), GIS data (the COMPASS Malawi GIS Database) and instructional materials to help the EDO's use their new technical tools (ArcExplorer User Manual, case studies, sample maps, etc.).

The COMPASS Malawi GIS Database is one of the most important components of the resource kit. The database is comprised of twenty four layers of geographic data, many of which are attached to attribute tables that define the non-spatial characteristics of the geographic features. The text box at right lists the twenty-four geographic layers in the database. Three tables of agricultural statistics not attached to geographic layers are also included in the database. Formatted as Excel spreadsheets, these files give agricultural area, yield and production data for 154 Extension Planning Areas. The files contain data covering a 15-year period from 1984 to 1998 for five crops, and data for the five years from 1994 to 1998 for eight crops. Attachment VI presents a detailed description of both the spatial and the attribute data contained in the COMPASS Malawi GIS Database.

The database is large and it contains a lot of very useful spatial information, but its value to the participants in this training course will be more as a learning resource than as source of useful information. Most of the layers are national in scope and contain little detail for sub-district level analysis and mapping, which is what EDO's are generally interested in. This limitation demonstrated an important principle to the participants - that spatial datasets prepared

- |                                 |                              |
|---------------------------------|------------------------------|
| 1. 1998 Census Enumeration Area | 13. National Boundary        |
| 2. Agricultural Schemes         | 14. National Parks           |
| 3. Agroclimatic Zones           | 15. Proposed Forest Reserves |
| 4. Airports                     | 16. Protected Areas          |
| 5. COMPASS Districts            | 17. Regions                  |
| 6. Districts                    | 18. Rivers and Streams       |
| 7. Extension Planning Areas     | 19. Soils                    |
| 8. Forest Reserves              | 20. Traditional Areas        |
| 9. Lakes                        | 21. Transportation Routes    |
| 10. Landcover 1973              | 22. UTM Grid                 |
| 11. Landcover 1991              | 23. Vegetation               |
| 12. Major Settlements           | 24. Wildlife Reserves        |

by third parties rarely meet a user's specific requirements for detail, accuracy, content and geographic scope. For the purposes of this intermediate-level training course, the database was perfectly adequate, but for the advanced course proposed in Section 5, methods for establishing and developing more detailed, district-specific spatial datasets will be an important focus.

## 4. Course Evaluation

Seven of the nine participants completed a simple course evaluation form. The respondents rated all aspects of the course at least “satisfactory” with most participants rating the contents of the course, the teaching methods, the materials used, the pace of instruction and the accommodation and food as “good” or “very good”. Not a single element of the course was rated “poor” or “very poor”. The table below summarizes the responses received from the 7 trainees who completed the course evaluation form.

		<b>Very Good</b>	<b>Good</b>	<b>Satisfactory</b>	<b>Poor</b>	<b>Very Poor</b>
1.	The contents of the training course	7				
2.	The hands-on method of teaching	7				
3.	The speed at which we covered the work	3	4			
4.	The laboratory and computer equipment			7		
5.	The instructor	7				
6.	The venue and location at Bunda	4	2	1		
7.	The field trips	2	4	1		
8.	The GIS Resources Kit	4	3			
9.	Accommodation and food	2	2	3		
10.	The relevance of what you learned to your daily work or research	7				

When asked what they liked most about the course, most participants highlighted the hands-on approach to learning GIS. Having experienced other teaching methods such as lectures, presentations and seminars, the participants were very pleased to be given the opportunity to develop some practical skills they can use in their daily work. The trainees also appreciated being able to use Malawian data for the course because they were able to relate to the issues their analyses and mapping projects were addressing.

The main complaint about the course concerned the quality of the computer equipment. The APATU computer laboratory was equipped in 1996 and none of the computers have been upgraded since then. A few of the computers worked reasonably well but most of them were very slow, had insufficient memory and storage space, were infected with viruses and prone to crashing, and did not have appropriate drivers installed to run the laboratory’s printer and external CD drive. APATU staff made every effort to keep the computers up and running, and at one stage brought in 3 newer machines they managed to borrow from other departments. But the participants were justifiably frustrated by frequent interruptions for re-booting, troubleshooting and re-installing software, delays that probably accounted for 2 full days of the 11-day course.

Most of the participants expressed interest in receiving additional training using a similar approach but covering more advanced mapping and GIS techniques. Collecting spatial

data, putting into computer-readable format, and editing geographic and attribute data are just some of the topics we did not have time to cover adequately in this short, intermediate-level course. To improve efficiency and reduce frustration, the EDO's offered to bring along their own computers and printers to any future training sessions.

## **5. Conclusions and Recommendations**

The intermediate level GIS for Natural Resource Managers training course was effective in that it gave the trainees knowledge and a set of skills that they themselves consider to be useful and relevant to their work. The EDO's have taken their skills back to the districts and will hopefully have the opportunity to practice the techniques and procedures they learned on a regular and frequent basis. Computer mapping and GIS is not something that can be learned in 2 weeks in a classroom setting – daily work with the software and the databases is necessary to reinforce what was learned in the classroom and maintain familiarity with the abstract concepts, strange jargon and complex command sequences associated with GIS. After a gap of a few months, during which the EDO's can put their GIS skills to the test in the real world, it would be useful to conduct a follow-up training course. The purpose of this course would be to troubleshoot any problems the EDO's encounter in their real world GIS experience, and then to move on to introduce more advanced techniques and procedures for collecting, inputting, analyzing and presenting spatial data and information.

**Recommendation: COMPASS should arrange to conduct a follow-up, advanced GIS training course for the same group of participants. The advanced course should be held soon so that the EDO's and other trainees can continue to build on the intermediate-level skills they have recently acquired. A two-week session in January or February 2003 would be appropriate.**

Many of the participants expressed frustration at being limited to the canned dataset provided as part of the resource kit. Though very rich at the national level, the database provides very little detail about the geography within individual districts. Clearly GIS will only be useful to the EDO's if they have access to data that show spatial variations *within* districts as well as differences between districts.

**Recommendation: Collecting and inputting detailed, sub district-level data should be the major theme of any follow-up training course.**

With data input as a major theme, the advanced training course would develop skills in working with GPS data, interpreting satellite images and aerial photographs, digitizing from source maps, and creating attribute files from sources of tabular data. These topics are entering the realm of field surveying and remote sensing, and it would obviously be important to engage a specialist with the appropriate skills and experience to provide this kind of training.

**Recommendation: COMPASS should identify a qualified remote sensing and image-interpretation specialist to lead parts of the advanced training course.**

For the remote sensing and image interpretation training to be effective, it is essential that the instructor does some preparatory work prior to the course. Specifically he or she



should acquire recent Landsat data for selected districts in Malawi, process the data to produce color composites, and have the composites printed as photograph-quality images. The participants in the advanced training course would then interpret the images to define land cover and land use units which they would then verify through GPS-assisted surveys in the field. A full Landsat scene covers a 185 x 185 km area and costs \$600. Two full scenes would probably be sufficient to cover the six districts that are likely to be represented at the advanced training course.

**Recommendation: COMPASS should seek USAID-approval to acquire satellite data as soon as possible to allow enough time for the data to be processed and printed prior to conducting the advanced training course early in 2003.**

As a venue, Bunda College has many positive points – the accommodation and food is excellent, the rooms are quiet and spacious, the campus is remote and offers few distractions, and the site is relatively accessible to participants coming from different parts of Malawi. However, the computer facilities at Bunda College's APATU laboratory are not good enough for future GIS training courses - the equipment there is old, under-powered and unreliable.

**Recommendation: COMPASS should consider using Bunda as the venue for the advanced GIS training course, but it should look for an alternative source of computer equipment.**

All the EDO's participating in the intermediate course have received computers from DANIDA within the last two years, and it would be much more efficient and effective if these computers could be used for future training initiatives. The EDO's all offered to make their computers available.

**Recommendation: The EDO's and other participants should be asked to bring their own computers and printers to the advanced GIS training program.**

This would allow the trainees to learn on newer, faster and more reliable machines; they would be working on computers they are familiar with; and, the participants could take the work they do during the course back home to their respective districts where they could continue to develop applications into which they will have already invested a good deal of time and effort.

The trainees each received a copy of ArcExplorer software as part of the COMPASS GIS Resources Kit, but not all of them have access to ArcView in their work places. ArcExplorer's functionality is quite limited, and although useful as a means of introducing the participants to computer mapping and GIS concepts, techniques and procedures, it will be of very limited practical use to the EDO's in their daily work. DAI has asked the software publishers, ESRI, to donate some ArcView licenses to Malawi's Environmental Affairs Department, but the response to-date has not been encouraging. We will continue to push ESRI to make the donation, but if that does not work, we will explore alternative means by which the EDO's can obtain copies of ArcView. To purchase ArcView for the six EDO's who attended the intermediate training course would cost approximately \$12,000.

**Recommendation: COMPASS should consider purchasing 6 ArcView 3.3 licenses for the EDO's that participated in the intermediate-level GIS training course.**

## **Attachment I**

### **List of Participants**

1. Lingstone Chiona, District Environmental Officer, Mangochi
2. Wezi Gausi, District Environmental Officer, Rumphi
3. Biswick Mlaviwa, District Environmental Officer, Machinga
4. Jacinta Chipendo, District Environmental Officer, Zomba
5. Stanley Kamtsitsi, District Environmental Officer, Dedza
6. Maxwell Kawerama, District Environmental Officer, Chikwawa
7. Dr. John Mfuné, Lecturer, Chancellor College, University of Malawi, Zomba
8. Luke Malembo, COMPASS Information Management Specialist, COMPASS, Blantyre
9. Francis Ngopola, COMPASS Grants Field Officer, COMPASS, Blantyre



## **Attachment II**

# **Training Course Schedule and Daily Outlines and Objectives**

## Week 1

Date	Time	Topic
Monday, September 9 <sup>th</sup>	AM	Introductions, course objectives and outline
	PM	Installing ArcExplorer; Moving around in the ArcExplorer window
Tuesday, September 10 <sup>th</sup>	AM	The nature of geographic data and information
	PM	The structure and contents of the GIS database for NRM in Malawi
Wednesday, September 11 <sup>th</sup>	AM	Using the GIS database for NRM in Malawi
	PM	Field trip, Dzalanyama Forest Reserve
Thursday, September 12 <sup>th</sup>	AM	Creating maps with ArcExplorer – display properties, map tips, scale and insets
	PM	Communicating information – classifying, symbolizing and labeling
Friday, September 13 <sup>th</sup>	AM	Querying attribute databases – identifying, selecting, generating statistics
	PM	Review of Week 1 – class discussion
Saturday, September 14 <sup>th</sup>	AM	Advanced functionality of ArcView GIS - optional class for advanced students
	PM	

## Week 2

Date	Time	Topic
Monday, September 16 <sup>th</sup>	AM	Printing, copying and saving ArcExplorer maps and projects
	PM	Review of GIS applications and case studies – class discussion
Tuesday, September 17 <sup>th</sup>	AM	Preparing for individual student projects – defining scope, objectives and outputs, and organizing databases
	PM	Work on individual projects
Wednesday, September 18 <sup>th</sup>	AM	Continue work on individual projects
	PM	Continue work on individual projects or field trip (optional)
Thursday, September 19 <sup>th</sup>	AM	Student presentations of the results of their individual projects
	PM	Continue student presentations
Friday, September 20 <sup>th</sup>	AM	Review Week 2 and conclude training course
	PM	

## **Day 1 – Outline and Objectives**

9<sup>th</sup> September 2002

- Introductions and Administration
- Lecture and Discussion
  - Course Objectives
  - Course Outline
  - Some Fundamental Principles of GIS
  - Needs Assessment
- Load GIS for Natural Resources Managers CD onto Computers
- Install and Test ArcExplorer Software
- Introduce the ArcExplorer Window
- Produce a Map of Countries of Africa
- Produce a Map of Population Distribution in the U.S.A.

## **Day 2 – Outline and Objectives**

10<sup>th</sup> September 2002

- Produce a Map of Population Distribution in the U.S.A.
- Produce a Map of Population Distribution in Malawi
- Working with ArcExplorer Project Files
- Class Discussion - the Nature of Geographic Data and Information
- Exploring the ArcExplorer Window
- Case Study – Forest Land Use Planning in the Philippines
- Examining the themes of the Malawi GIS Database
- Obtaining Attribute Information from the Malawi GIS Database
- Produce a Map of Vegetation Cover in Malawi

## **Day 3 – Outline and Objectives**

11<sup>th</sup> September 2002

- Exercise – Querying the attribute database of the Forest Reserve theme
- Disk Management and Computer Maintenance
- Class Discussion – Review the Nature of Geographic Data and Information
- The ArcExplorer Menu and Scale Bar
- Mapping Vegetation Cover in Malawi
- Collecting Data with a GPS Receiver – Field Trip to Dzalanyama Forest Reserve

## **Day 4 – Outline and Objectives**

12<sup>th</sup> September 2002

- Exercise – Land Cover Analysis
- Review of Key Terms and Expressions
- Symbolization – Working with line weights, fill and color
- Operating a GPS Receiver (continued)
- Shifting Gear – Introducing ArcView GIS
- Querying Attribute Tables in ArcView GIS
- Map Elements and the Layout Window
- Mapping Malawi's 1991 Land Cover



## **Day 5 – Outline and Objectives**

13<sup>th</sup> September 2002

- Complete Maps of Malawi's 1991 Land Cover
- Getting Organized - ArcView Project Files
- Themes, Shape Files, ARC/INFO Coverages, Raster Images
- View, Theme and Layout Properties
- Why Is My Scale-Bar Empty? Specifying Map Units and Distance Units
- Introducing the Geo-Processing Wizard
- Preparing to Map Southern Region – Selecting, Converting-to-Shapefiles and Clipping
- Managing a Spatial Database with Windows Explorer

## **Day 6 – Outline and Objectives**

14<sup>th</sup> September 2002

- Internal and External Attributes
- Introducing Scripts – Re-Calculating Area, Length and Perimeter Values after Clipping
- Mapping Protected Areas in Southern Region
- A Review of Material Covered in Week 1
- Quick Quiz on GIS Terms, Concepts, Functions and Operations

## **Day 7 – Outline and Objectives**

16<sup>th</sup> September 2002

- Finish Compiling and Printing Maps of Protected Areas in Southern Region
- Clipping Review – Make a Subset of 24 Themes for One District
- Some Differences between Computer Mapping and Spatial Analysis
- A Closer Look at Attributes – The Spatial Data Dictionary
- Working with Tables – Sorting, Calculating Fields, Editing
- Spatial Analysis – Creating Buffers, Selecting-by-Theme, Overlaying Themes
- On-Screen Digitizing – Creating a New Point Theme

## **Day 8 – Outline and Objectives**

17<sup>th</sup> September 2002

- The Great Ntcheu District Mystery – Why does Ntcheu District appear in the SR Districts theme, and what can we do to correct the data?
- Spatial Analysis – Creating Buffers, Selecting by Theme, Overlaying Themes
- Thematic Mapping Techniques – Graduated Color, Unique Value and Dot Density Maps
- On-Screen Digitizing - Creating a New Point Theme
- Clipping Review – Make a Subset of 24 Themes for Your District
- Preparing for Individual District Projects – Objectives, Approach and Timetable for Creating an Environmental Atlas for a District in Malawi

## **Days 9, 10 and 11 – Outline and Objectives**

18<sup>th</sup> – 20<sup>th</sup> September 2002

### **Individual Spatial Analysis and Mapping Projects.**

Compile and print 4 or 5 maps for the geographic area of your choice. The geographic area you choose should be a single region or district of Malawi. The maps should illustrate some environmental or natural resources management issues you feel are significant in your region or district. Examples might include maps showing the following:

- Population pressure threatening protected areas due to close proximity to major settlements, roads or airports.
- Opportunities for eco-tourism in protected areas due to close proximity to major settlements, roads or airports.
- Threats to water quality from pollution and excessive soil erosion caused by intensive agricultural activity along the banks of rivers and streams.
- Depletion of forest resources between 1973 and 1991.
- Importance of good forest cover to protect water sources upstream of major population centres.
- The extent of forest cover in National Parks and Forest Reserves in 1991.

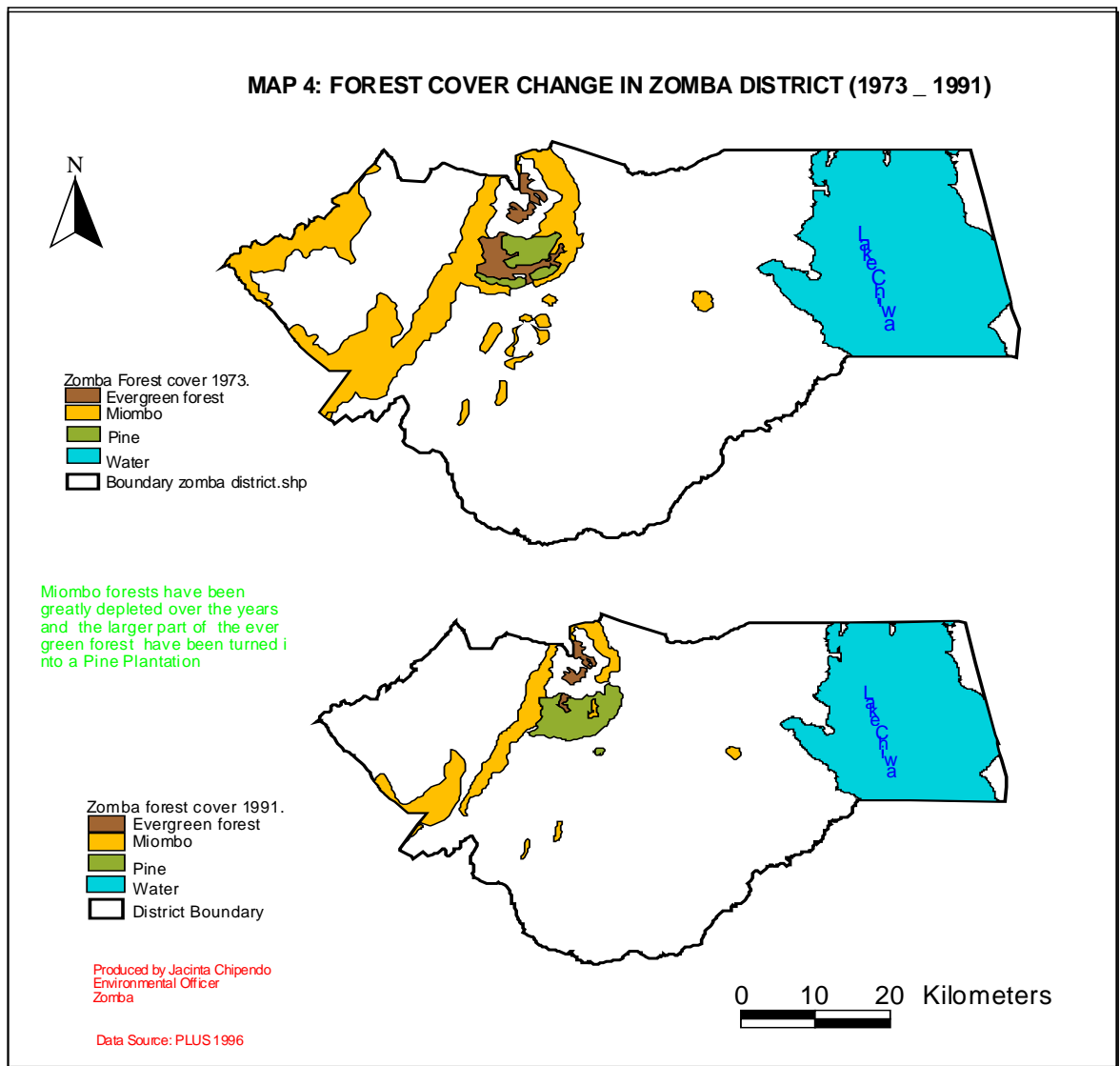
You have until 12 noon on Friday to complete your project. Try to print drafts of all your maps before the end of class on Thursday to give you time on Friday morning to edit and improve them.



### **Attachment III**

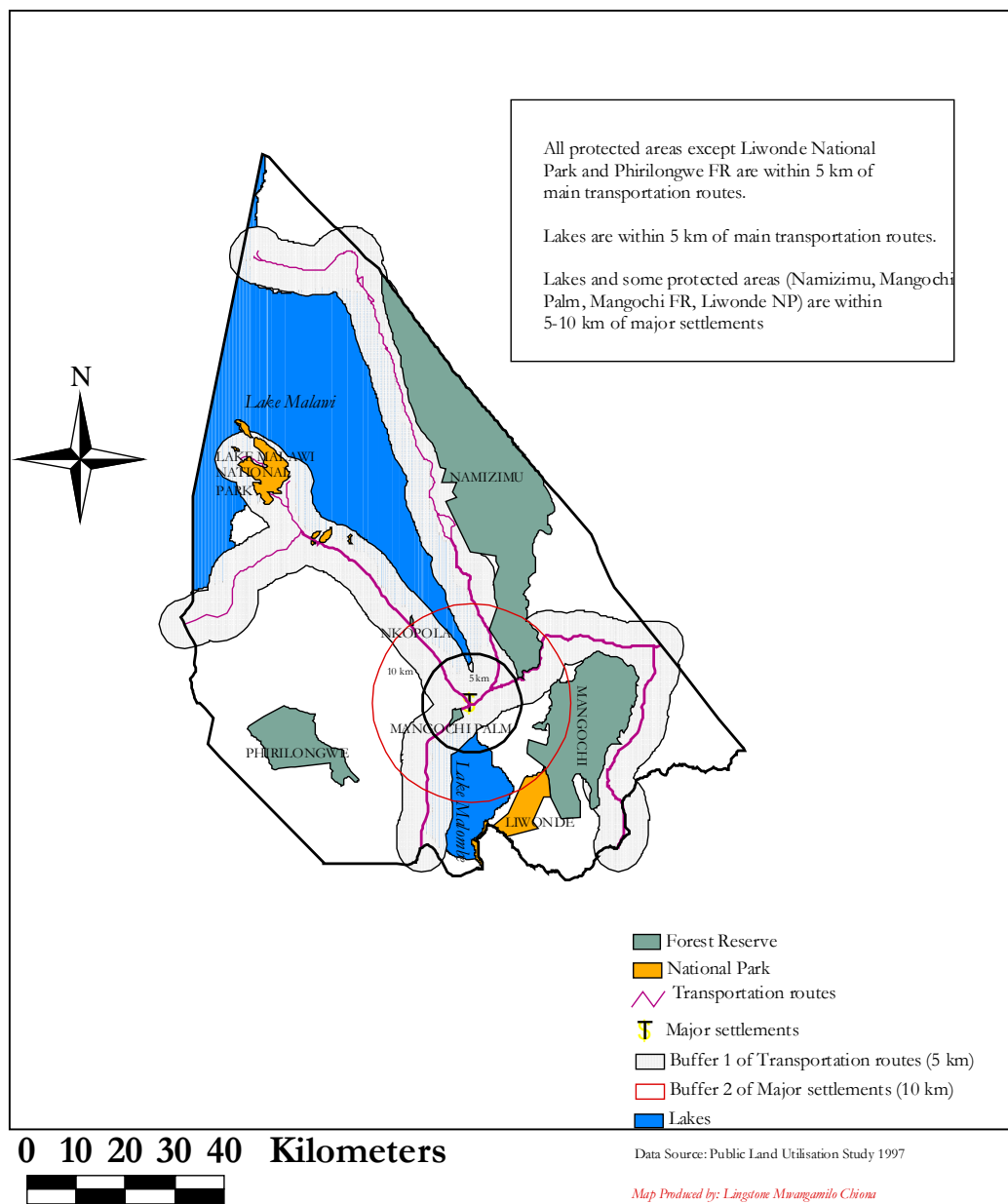
## **Examples of Maps Produced by Participants**





**Map 1**  
**Forest Cover Change in Zomba District, 1973 – 1991**  
 Prepared by Jacinta Chipendo, District Environmental Officer, Zomba

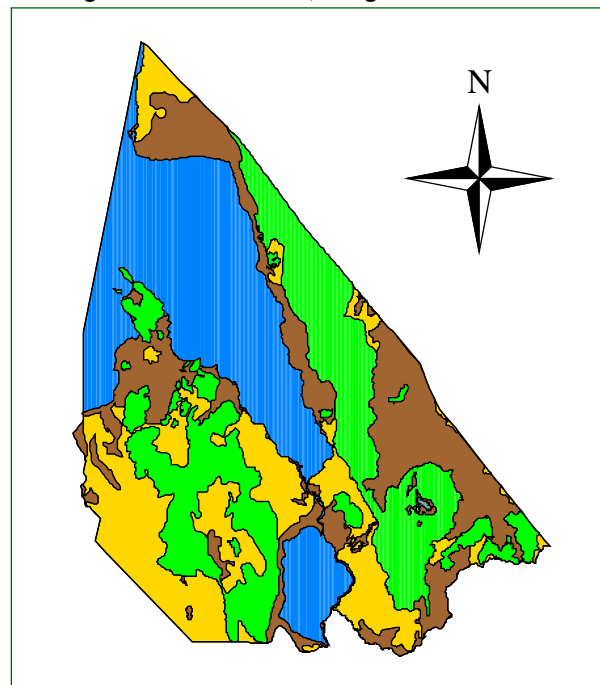
**Fig 2: Eco-tourism Opportunities in Mangochi District**



**Map 2**  
**Eco-Tourism Opportunities in Mangochi District**  
Prepared by Lingstone Chiona, District Environmental Officer, Mangochi



Fig 3.1: Landcover 1973, Mangochi District

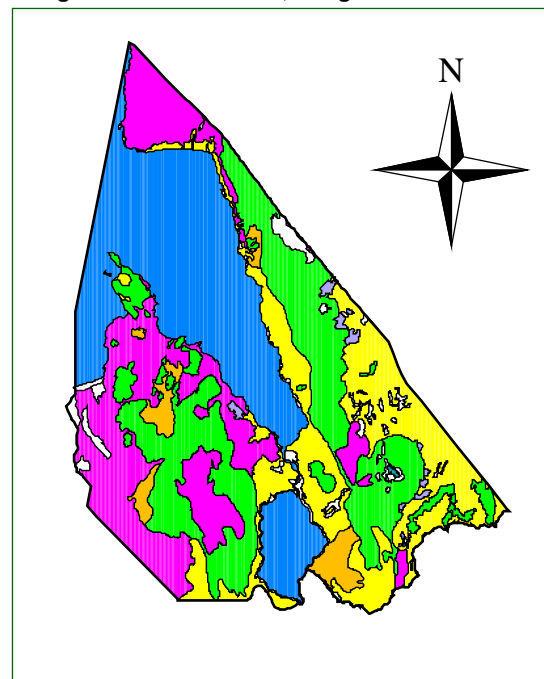


0 10 20 30 40 50 Kilometers

**Landcover 1973**

- Evergreen forest
- Miombo in flat area
- Miombo in hilly area
- unclassified
- water

Fig 3.2: Landcover 1991, Mangochi District

**Landcover 1991**

- Agriculture in forest area
- Arable land
- Evergreen forest
- Miombo in hilly area
- Tobacco & Maize
- Water surface

Data Source: PLUS 1997

Map Prepared By:

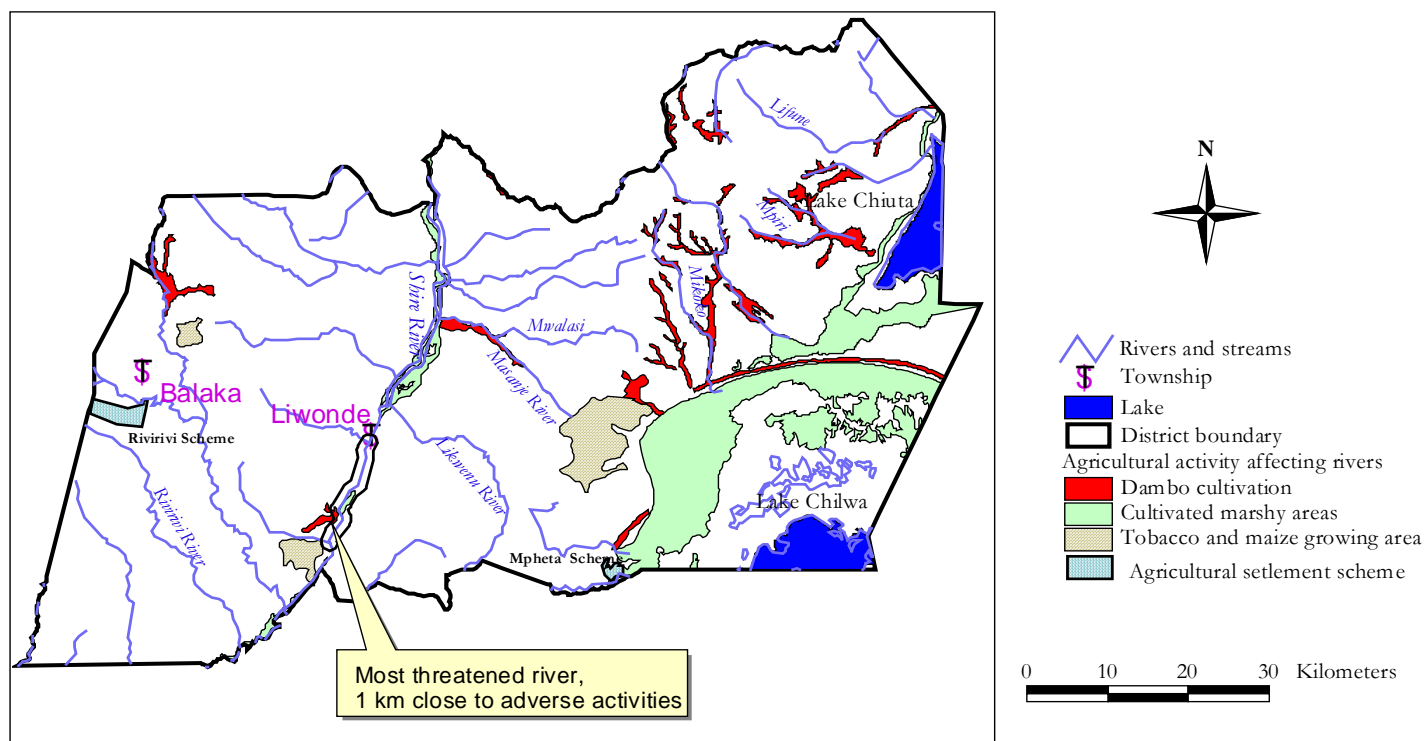
Lingstone Chiona

Date: 19th Sept. 2002

**Map 3****Landcover Change in Mangochi District, 1973-1991**

Prepared by Lingstone Chiona, District Environmental Officer, Mangochi

**Map 2: Threats to water quality from pollution and excessive soil erosion in water bodies of Machinga**



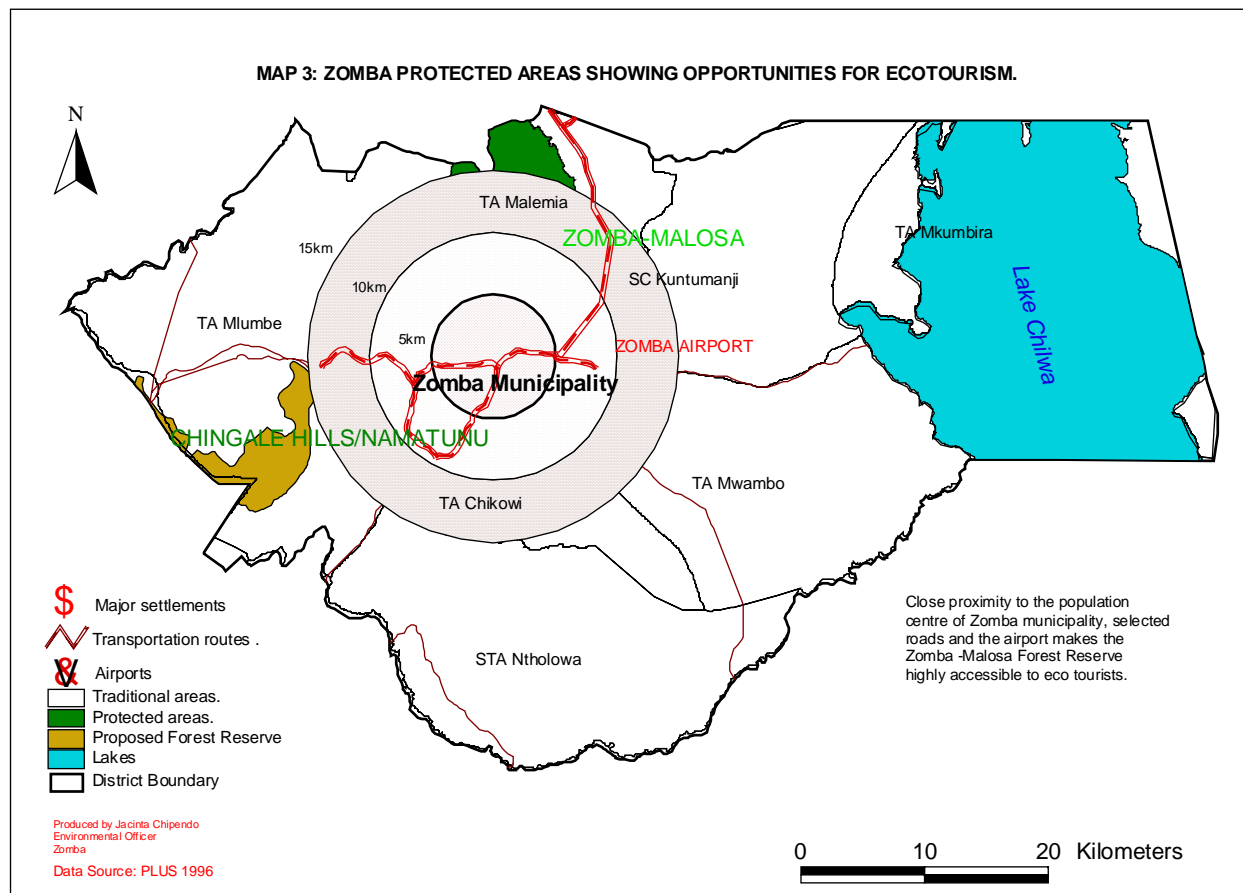
Designed by: Biswick Mlaviwa  
Date: 19th Sept, 2002

Data Source: Public Land Utilisation Study, 1996

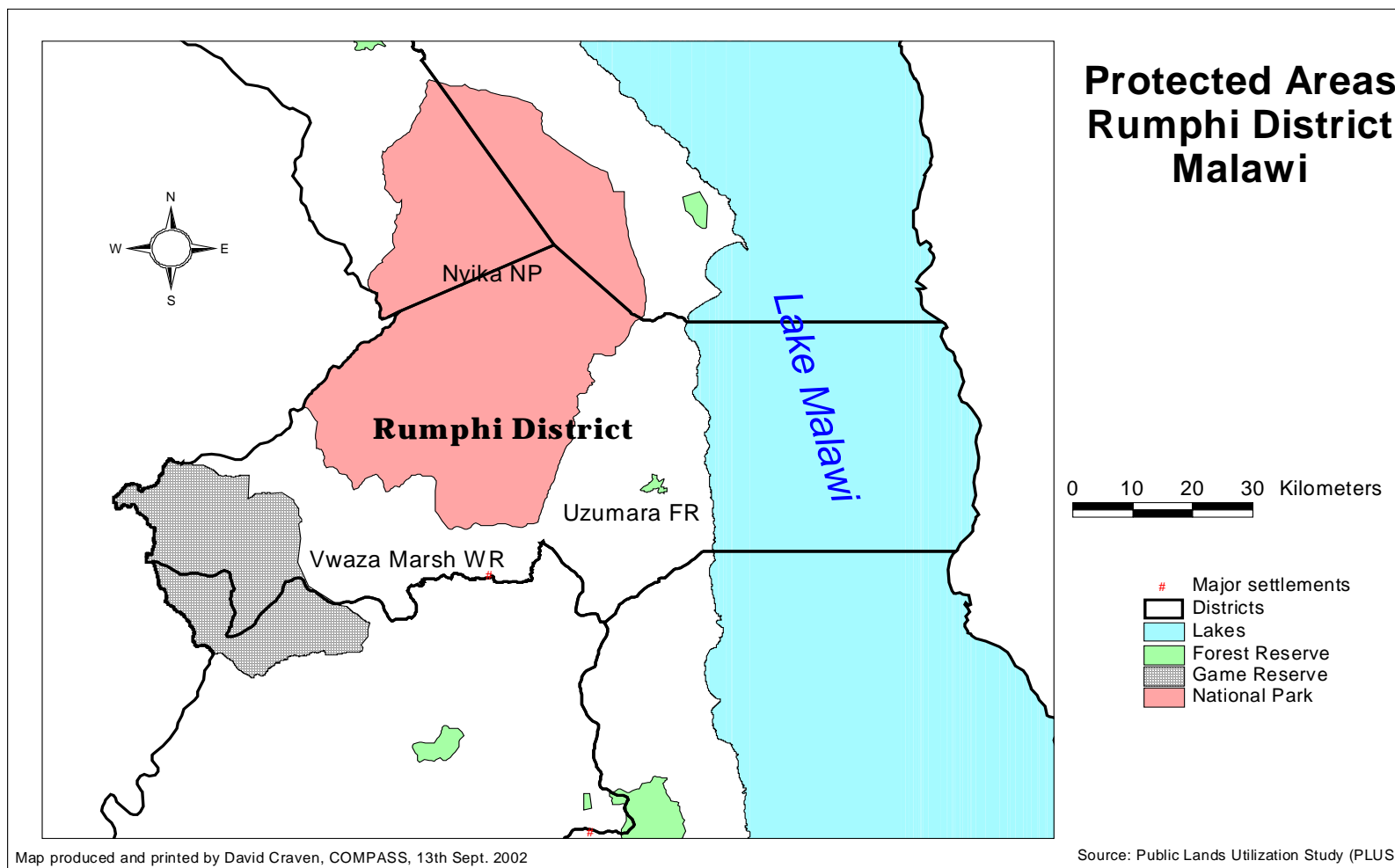
**Map 4**

**Threats to Water Quality from Pollution and Excessive Soil Erosion in Water Bodies of Machinga District**

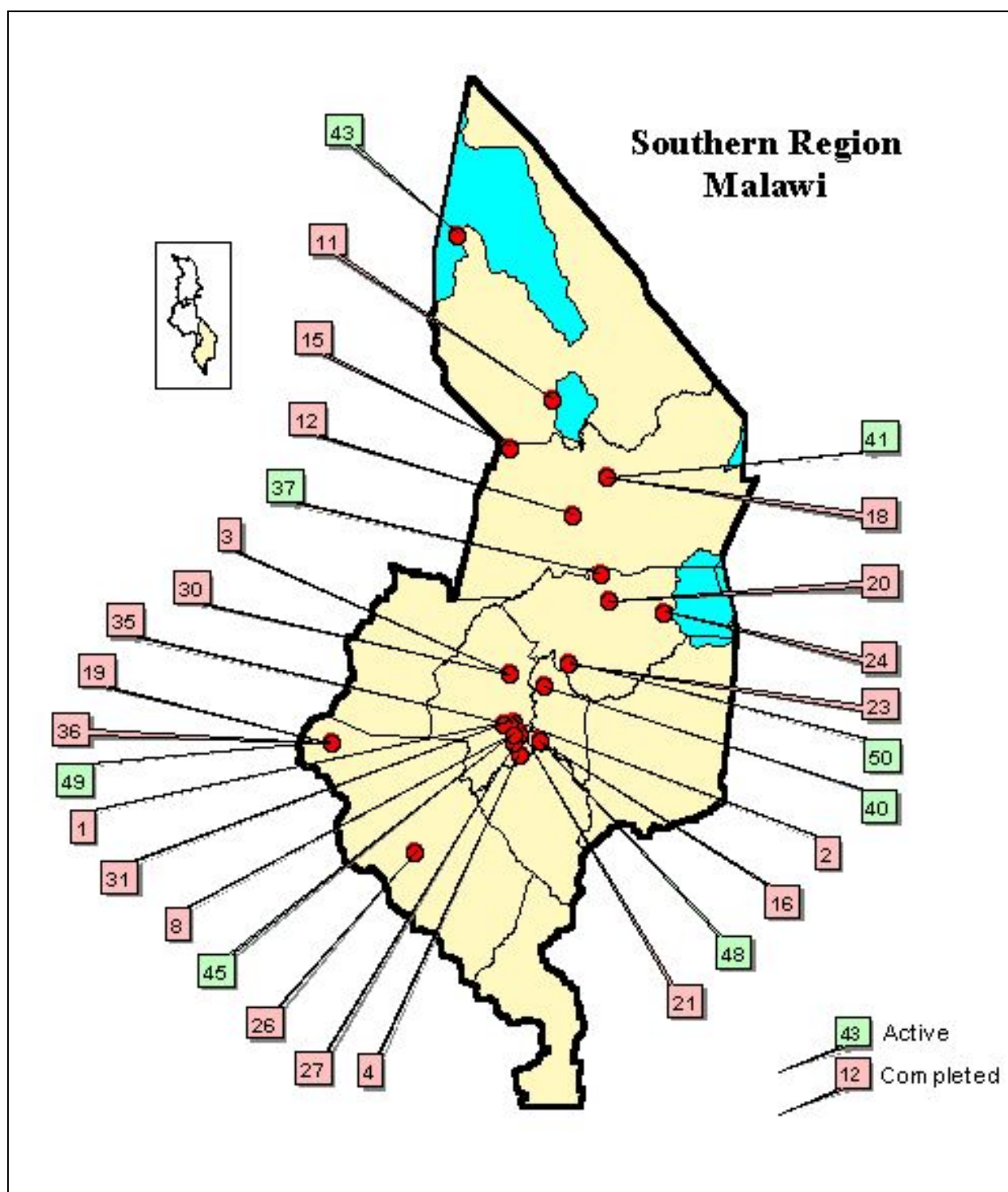
Prepared by Biswick Mlaviwa, District Environmental Officer, Machinga



**Map 5**  
**Opportunities for Eco-Tourism in Protected Areas of Zomba District**  
 Prepared by Jacinta Chipendo, District Environmental Officer, Zomba



**Map 6**  
**Protected Areas of Rumphi District**  
 Prepared by Wezi Gausi, District Environmental Officer, Rumphi



**Map 7**  
**COMPASS Grant Sites in Southern Malawi**  
 Prepared by Luke Malembo, COMPASS Information Management Specialist



**Attachment IV**

**Contents and Structure of the COMPASS GIS for  
Natural Resource Managers CD**

# GIS FOR NATURAL RESOURCE MANAGERS

## Contents and Structure of the GIS for Natural Resource Managers CD



The contents of the GIS for Natural Resource Managers CD are organized into folders and files. To help the reader distinguish between the two, the names of **folders** are printed in bold and the names of *files* are printed in italics.

The seven first-level folders on the CD are named as follows:

- **Adobe**
- **ArcExplorer Software and User Manual**
- **GIS Case Studies**
- **GIS Data Dictionary**
- **GIS Database**
- **Maps and GIS Applications**
- **Useful Addresses on the World Wide Web**

The contents of each of these folders are described below.

**Adobe** – Contains the software and documentation needed to run Adobe Acrobat 5.0.5. This program is required to open and print documents stored in .pdf format.

**ArcExplorer Software and User Manual** – Contains two files:

- *ae2setup.exe* – the executable file that will install ArcExplorer 2.0 on your computer.
- *ArcExplorer.pdf* – the electronic version of the ArcExplorer User Manual in .pdf format. This is the document in Section B of your Resource Kit.

**GIS Case Studies** – In addition to the folders and files for the case studies presented in Section F of the Resource Kit, this folder also contains a number of other case studies. The files in this folder include the following:

- *A GIS- based approach for participatory decision making in Mexico a case study in the Sierra De Manantlan biosphere reserve.htm*
- *ACC Profile.doc*
- *Forest Monitoring in Malawi.pdf*
- *GIS for Africa.pdf\**
- *GIS for Managing Forests.pdf\**
- *GIS for Production Agriculture.pdf\**
- *Imbirikani Ranch Land Use Plan.pdf*
- *Participatory GIS with the Ifugao Peoples.htm*
- *Tracking Pesticide Use.pdf*

Files marked \* are not included as printed documents in the Resource Kit



**GIS Data Dictionary** – This folder contains one file - *GIS Data Dictionary.doc*. This Microsoft Word document describes the contents and structure of the geographic and attribute data contained in the folder **GIS Database**. The printed version is contained in Section D of your Resource Kit.

**GIS Database** – This folder contains all the spatial data you will use with ArcExplorer during this training course. The data are stored in two sub-folders called **Malawi** and **Fews Agricultural Data**.

**Malawi** – Contains 24 layers of geographic data stored as ArcExplorer-compatible shape files. The names of the layers, most of which are self-explanatory, are as follows:

13. 1998 Census Enumeration Area	25. National Boundary
14. Agricultural Schemes	26. National Parks
15. Agroclimatic Zones	27. Proposed Forest Reserves
16. Airports	28. Protected Areas
17. COMPASS Districts	29. Regions
18. Districts	30. Rivers and Streams
19. Extension Planning Areas	31. Soils
20. Forest Reserves	32. Traditional Areas
21. Lakes	33. Transportation Routes
22. Landcover 1973	34. UTM Grid
23. Landcover 1991	35. Vegetation
24. Major Settlements	36. Wildlife Reserves

More details about each of the data layers are given in the GIS Data Dictionary.

**FEWS Agricultural Data** – Comprised of three Microsoft Excel files containing agricultural area, yield and production data for 154 Extension Planning Areas. The three files are:

- *EPAAREA.XLS*
- *EPAYIELD.XLS*
- *EPAPROD.XLS*

Again, a more detailed description of this attribute data is given in the GIS Data Dictionary.

**Maps and GIS Applications** – This folder contains all of the documents presented in Section E of the Resource Kit. It also contains the draft of “Malawi – An Atlas of Social Statistics”, which is soon to be published in hard copy by the NSO. The files in the folder are as follows:

- *ACC Community Conservation Projects.pdf* – a document containing four maps produced by the African Conservation Centre, including the land use plan for the Imbirikani Ranch shown in Section E of the Resource Kit.
- *Malawi Agricultural Schemes Map.doc* – the agricultural schemes map from the Resource Kit, stored as a Microsoft Word Document.
- *Malawi Agricultural Schemes Map.wmf* – the same map, stored as a Windows Metafile which can be imported as a graphic into Microsoft and many other software applications.
- *Malawi Protected Areas.pdf* – contains both the map and the attribute table for Malawi’s protected areas.
- *Malawi\_atlas\_draft2.pdf* – the draft Malawi Atlas of Social Statistics. This document is not included in printed form in the Resource Kit.
- *Malawi’s Agricultural Schemes.pdf* – the attribute table associated with the agricultural schemes map.

**Useful Addresses on the World Wide Web** – This folder contains one file called *GIS Web Links.doc*, a Microsoft Word document listing the addresses of twelve web sites that are useful sources of data and information related to GIS and natural resources management. Some of the sites provide free maps, reports and/or GIS data (Data Depot, NSO, Africa Data Dissemination Service, University of Texas, FEWS), others explain technical terms and concepts associated with the mapping sciences (University of Oregon, University of Edinburgh, United States Geological Survey), and others are specifically concerned with GIS and/or NRM in Malawi (MEMP, COMPASS, Project Africa).

**Attachment V**

**Useful Web Addresses for Malawian GIS  
Technicians**

## GIS FOR NATURAL RESOURCE MANAGERS

### Useful Web Addresses



<http://216.239.35.100/search?q=cache:F-o6gki1NB4C:www.nso.malawi.net/home.htm+Malawi+NSO&hl=en&ie=UTF-8>

Home page of the Malawi National Statistical Office. Online versions of recent census data, Malawi in Figures and the Statistical Yearbook from 2001, Malawi's Strategic Plan for 2002-2006, and numerous other sources of socio-economic data.

<http://www.compass-malawi.com/>

Home Page of the Community Partnership for Sustainable Resource Management (COMPASS) web site. Describes COMPASS activities, results and grants management programme, and an excellent source of information about CBNRM-related publications, training programmes, best practices and partner organizations.

<http://www.gisdatadepot.com/catalog/MI/>

GIS DataDepot, a site offering free GIS data, including data for Malawi.

<http://ag.arizona.edu/OALS/malawi/Malawi.html>

Malawi Environmental Monitoring Program (MEMP) site, jointly hosted by the Office of Arid Lands Studies, University of Arizona, and Clarke University in Worcester, Massachusetts. Reports, papers, work plans, and maps, photographs and figures from the Public Lands Utilization Study (PLUS)

<http://www.projectafrica.com/hippoexped2002.htm>

Project Africa's 2002 Lake Malawi Hippo Expedition to conduct a comprehensive hippo census for the lake. The team will use GIS to manage and analyze the data. The expedition is scheduled for October, and they're looking for volunteers!

<http://www.usgs.gov/research/gis/title.html>

United States Geological Survey site – a good introduction to GIS terms, concepts and applications.

## GIS FOR NATURAL RESOURCE MANAGERS

### Useful Web Addresses



<http://www.geo.ed.ac.uk/agidict/welcome.html>

A dictionary of GIS acronyms, abbreviations and jargon, published by the Association for Geographic Information at the University of Edinburgh, Scotland, UK.

<http://edcsnw4.cr.usgs.gov/adds/adds.html>

The Africa Data Dissemination Service, a source of GIS data for Malawi and other African countries. Maintained by the USGS and USAID, and closely related to FEWS NET

<http://www.fews.net/>

The Famine Early Warning System Network home page. Regularly updated reports about food security issues including flooding, drought, harvests, emergency response planning, crop prices and desertification. Links to sites devoted to food security issues in Malawi.

<http://www.lib.utexas.edu/maps/africa.html>

Electronic maps of most African countries, including Malawi. Political and relief maps available.

<http://shiva.uoregon.edu/introGIS/lecture1.html>

Notes from an introductory GIS lecture at the University of Oregon. Asks and answers some interesting questions.

[www.esri.com](http://www.esri.com)

Home page of Earth Systems Resources Institute, producers of ArcExplorer, ARC/INFO and ArcView software.



## **Attachment VI**

# **Data Dictionary for the COMPASS Malawi GIS Database**



# GIS FOR NATURAL RESOURCE MANAGERS

## Data Dictionary for Malawi GIS Database

### 1. Spatial Database

File Name	Number of Features	Description	Attribute Field Name	Attribute Description
1998 census enumeration areas.shp	9,218	Boundaries of Census Enumeration Areas (EA's), as used in the 1997/98 household survey conducted by the NSO and IFPRI	Area	Area of each enumeration area in square metres
			Perimeter	Length of perimeter of each enumeration area in metres
			Eacode	Unique identification number for each enumeration area
			Tacode	Unique identification number for the TA each enumeration area is in
			Distcode	Unique identification number for the District each enumeration area is in
			Taname	Name of the TA each enumeration area is in
			District	Name of the district each enumeration area is in
			Eatype	Type of each enumeration area, classified as follows: <ul style="list-style-type: none"> <li>- Boma/Township</li> <li>- Forest/Park</li> <li>- Lake (units defining lakes in the shape file)</li> <li>- Pop Area</li> <li>- Trading Centre</li> </ul>
			Les50hh	
			Povmapward	
			X_coord	
			Y_coord	
			Hh	
			Hectares	Area of each enumeration area in hectares
			Sq_km	Area of each enumeration area in square kilometres



File Name	Number of Features	Description	Attribute Field Name	Attribute Description
<b>Agroclimatic zones.shp</b>	371	Boundaries of agro-climatic zones in Malawi, describing average annual variations in rainfall, temperature, number of dry months and length of growing period	Area Perimeter Hectares Aczone Lgp Ppet Tgp Pan Dm Tan Tmin Tegp Sq_km	Area of each unit (feature) in square metres Length of perimeter of each unit (feature) in metres Area of each unit (feature) in hectares Agroclimatic zone codes assigned by LREP Mean length of growing period in months/year Ratio of precipitation to potential evapotranspiration Mean temperature during growing period in degrees Celsius Mean annual precipitation (units not known) Mean number of dry months per year Mean annual temperature in degrees Celsius Mean minimum temperature during coldest month in degrees Celsius Mean temperature during end of growing period in degrees Celsius Area of each unit (feature) in square kilometres
<b>Agricultural schemes.shp</b>	44	Boundaries of agricultural schemes in Malawi	Area Perimeter Hectares Scheme_nam Scheme_id Sq_km	Area of each agricultural scheme (feature) in square metres Length of perimeter of each agricultural scheme in metres Area of each agricultural scheme (feature) in hectares Name of each agricultural scheme Sequential identification number of each agricultural scheme Area of each agricultural scheme (feature) in square kilometres
<b>Airports.shp</b>	6	Locations of major airports in Malawi	Aeptname Aeptval Aeptdate Long Lat	Name of each airport Elevation of each airport in feet above mean sea level Year database was last updated Longitude of each airport in decimal degrees east of Greenwich Latitude of each airport in decimal degrees south of Greenwich
<b>National boundary.shp</b>	1	Boundary of Malawi	Area Perimeter hectares km_sq	Area of Malawi in square meters Length of Malawi's national boundary in meters Area of Malawi in hectares Area of Malawi in square kilometres

File Name	Number of Features	Description	Attribute Field Name	Attribute Description
<b>Major settlements.shp</b>	20	Locations of major towns and cities in Malawi	Ppptname	name of settlement
			Long	settlement longitude in decimal degrees
			Lat	settlement latitude in decimal degrees
			Popul87	settlement population, 1987
<b>Districts.shp</b>	24	Boundaries of districts in Malawi	Area	Area of each district (feature) in square metres
			Perimeter	Length of perimeter of each district (feature) in metres
			Hectares	Area of each district (feature) in hectares
			Km_sq	Area of each district (feature) in square kilometres
			Dist_name	Name of each district
			Dis_popul	Population of each district, 1987
			Poorperson	Number of poor people in each district, 1998
			Zpoorperso	% of Malawi's poor people living in each district, 1998
			Ultrapoore	Number of ultra poor people living in each district, 1998
			Zultrapoor	% of Malawi's ultra poor population living in each district, 1998
			Zdistpoppo	% of each district's population classified as poor, 1998
			Estpop98	Estimated total population of each district, 1998
<b>Compass districts.shp</b>	9	Boundaries of priority COMPASS districts in Malawi	Area	Area of each COMPASS priority district (feature) in square metres
			Perimeter	Length of perimeter of COMPASS priority districts (features) in metres
			Hectares	Area of each COMPASS priority district (feature) in hectares
			Km_sq	Area of each COMPASS priority district (feature) in square kilometres
			Distname	Name of each COMPASS priority district
			Dispopul	Population of each COMPASS priority district, 1987
<b>Traditional areas.shp</b>	368	Boundaries of Malawi's Traditional Areas (TA's)	Tacode	NSO code numbers of individual TA's
			Sqkm	Area of each TA (feature) in square kilometres
			District	Name of district each TA is located in
			Taname	Name of each TA
			Distcode	NSO code number of district each TA is in
			Area	Area of each TA (feature) in square metres
			Perimeter	Length of perimeter of each TA (feature) in metres
			Hectares	Area of each TA (feature) in hectares

File Name	Number of Features	Description	Attribute Field Name	Attribute Description
<b>Extension planning areas.shp</b>	221	Boundaries of Extension Planning Areas (EPA's) in Malawi	Area	Area of each EPA (feature) in square metres
			Perimeter	Length of perimeter of each EPA (feature) in metres
			Hectares	Area of each EPA (feature) in hectares
			Km_sq	Area of each EPA (feature) in square kilometres
			Zid	FEWS identification code
			Popdns87	Number of inhabitants per km-sq, 1987
			Zname	Name of each EPA
			Zname2	Numeric name code
			Sam_id	Numeric code assigned by somebody called Sam!
			Pop87	EPA population, 1987
<b>Proposed forest reserves.shp</b>	36	Boundaries of proposed Forest Reserves in Malawi	Area	Area of each proposed Forest Reserve (feature) in square metres
			Perimeter	Length of perimeter of each proposed Forest Reserve in meters
			Name	Name of each proposed forest reserve
			Status	Status code, 0 or 4, meanings not known
			Hectares	area of each proposed Forest Reserve (feature) in hectares
			Km_sq	area of each proposed Forest Reserve (feature) in square kilometres
<b>Forest reserves.shp</b>	71	Boundaries of Forest Reserves in Malawi	Area	area of each forest reserve (feature), in square metres
			Perimeter	length of perimeter of each forest reserve (feature), in metres
			Hectares	area of each forest reserve (feature) in hectares
			Km_sq	area of each forest reserve (feature) in square kilometres
			Name	name of each forest reserve
<b>Lakes.shp</b>	4	Boundaries of Malawi's four major lakes	Place	name of each lake
			Area	Area of each lake, in square metres
			Perimeter	Length of perimeter of each lake (feature), in metres
			Hectares	Area of each lake (feature) in hectares
			Sq_km	Area of each lake (feature) in square kilometres

File Name	Number of Features	Description	Attribute Field Name	Attribute Description
<b>Landcover 1973.shp</b>	871	Boundaries of land cover units in Malawi, 1973	Area	Area of each land cover unit (feature), in square metres
			Perimeter	Length of perimeter of each land cover unit (feature), in metres
			Hectares	Area of each land cover unit (feature), in hectares
			Km_sq	Area of each land cover unit (feature), in square kilometres
			Landcode	1973 land cover type code, numeric (see “name” field below)
			Name	200 = Evergreen forest
				201 = Miombo in hilly area
				202 = Miombo in flat area
				203 = Eucalyptus
				204 = Gmelina
				205 = Pine
				207 = Tung
				224 = Water
				299 = Unclassified

File Name	Number of Features	Description	Attribute Field Name	Attribute Description
<b>Landcover 1991.shp</b>	1,785	Boundaries of land cover units in Malawi, 1991	Area	Area of each land cover unit (feature), in square metres
			Perimeter	Length of perimeter of each land cover unit (feature), in metres
			Hectares	Area of each land cover unit (feature), in hectares
			Km_sq	Area of each land cover unit (feature), in square kilometres
			Landcode	1991 land cover type code, numeric (see “name” field)
			Name	200 = Evergreen woodland
				201 = Miombo in hilly area
				202 = Miombo in flat area
				203 = Eucalyptus plantation
				204 = Gmelina plantation
				205 = Pine plantation
				206 = Rubber plantation
				207 = Tung plantation
				208 = Logged area
				209 = Grass
				210 = Dambo
				211 = Savanna
				212 = Agriculture in forest area
				213 = Agriculture in grass area
				214 = Arable land
				215 = Coffee & Tea
				216 = Sugar
				217 = Tobacco & Maize
				218 = Leucaena
				219 = Rice scheme
				220 = Marshy area
				221 = Bare rock
				222 = River bed or bare ground
				223 = Built-up area
				224 = Water surface
				299 = Not classified

File Name	Number of Features	Description	Attribute Field Name	Attribute Description
<b>National parks.shp</b>	12	Boundaries of Malawi's five National Parks	Area	Area of each National Park (feature) in square metres
			Perimeter	Length of perimeter of each National Park (feature) in metres
			Hectares	Area of each National Park (feature) in hectares
			Km_sq	Area of each National Park (feature) in square kilometres
			Parkname	Name of each National Park
<b>Protected areas.shp</b>	87	Boundaries of Malawi's protected areas	Hectares	Area in hectares
			Km_sq	Area in square kilometres
			Name	Name of each Protected Area, uppercase text
			Type	Type of Protected Area, numeric codes described in "type_txt" field
				100
				200
				300
			Type_txt	Type of Protected Area
				100 = Forest Reserve
				200 = Game Reserve
				300 = National Park
			Name_low	Name of each Protected Area, lowercase text
			Prot_date	Year each PA given protected status
			Gaz_date	Year each PA gazetted
			Gaz_decade	Decade during which each PA gazetted
			Gaz_1964	Gazettement 1964 or earlier (1=yes, 2=no)
			Add_date	Date Agricultural Development District containing PA established
			Rationale1	Codes for primary reason each PA gazetted, listed in "r1_code" field

File Name	Number of Features	Description	Attribute Field Name	Attribute Description
Protected areas.shp (continued)			R1_code	1 = catchment protection 2 = water supply protection 3 = conservation of biodiversity 5 = fuelwood 6 = hardwood production 7 = softwood production 8 = research 12 = amenity value 13 = doubtful
			Rationale2 R2_code	Codes for secondary reason each PA gazetted, listed in "r2_code" field 0 = no secondary rationale for creation 1 = catchment protection 2 = water supply protection 3 = conservation of biodiversity 4 = local construction 5 = fuelwood 6 = hardwood production 7 = softwood production 8 = research 11 = sleeping sickness risk 12 = amenity value
			Rationale3 R3_code	Codes for tertiary reason each PA gazetted, listed in "r3_code" field 0 = no tertiary rationale for creation 4 = local construction 6 = hardwood production 7 = softwood production 9 = grazing 12 = local construction
			Rationale4 R4_code	Codes for quaternary reason each PA gazetted, listed in "r4_code" field 0 = no quaternary rationale for creation 5 = fuelwood
			Buffer_pop	1987 population within 5km of each Protected Area

File Name	Number of Features	Description	Attribute Field Name	Attribute Description
<b>Regions.shp</b>	5	Boundaries of Malawi's three regions	Area	Area of each region (feature) in square metres
			Perimeter	Length of perimeter of each region (feature) in metres
			Hectares	Area of each region (feature) in hectares
			Km_sq	Area of each region (feature) in square kilometres
			Rname	Name of each region ("north", "center", "south")
<b>Soils.shp</b>	241	Boundaries of soils units for all Malawi	Area	Area of each soil unit (feature) in square metres
			Perimeter	Length of each soil unit (feature) in metres
			Hectares	Area of each soil unit (feature) in hectares
			Km_sq	area of each soil unit (feature) in square kilometres
			Soil-id	Soil unit identification code
			Soil_type	Alphanumeric soil type code (meaning of codes not known)
			Assoc_1	Primary soil association, alphanumeric code (meanings not known)
			Assoc_2	Secondary soil association, alphanumeric code (meanings not known)
			Assoc_3	Additional soil association, alphanumeric code (meanings not known)
			Assoc_4	Additional soil association, alphanumeric code (meanings not known)
			Includ_1	Primary soil inclusion type code (meanings not known)
			Includ_2	Secondary soil inclusion type code (meanings not known)
			Includ_3	Additional soil inclusion type code (meanings not known)
			Includ_4	Additional soil inclusion type code (meanings not known)



File Name	Number of Features	Description	Attribute Field Name	Attribute Description
<b>Rivers and streams.shp</b>	1,263	Rivers and streams of Malawi	Dnlntype	Drainage network line type code, described in dnlntypetx field 1 2 9
			Dnlntypetx	Drainage network line type description, text 1 = streams, rivers or channelized rivers 2 = inland shorelines 9 = tile boundary or null arc
			DnlInstat	Drainage line status described in dnlInstattx field 1 3 99
			DnlInstattx	Drainage network line status description 1 = perennial 3 =definite, used for inland shorelines only 99 = none
			Kilometres	Length of stream or river section (feature) in kilometres
<b>Transportation routes.shp</b>	343	Roads of Malawi	Length	Length of road segment (feature) in metres
			Sym	Line symbol code, numeric 13 = Primary roads 14 = Secondary roads 15 = Trunk roads
			Kilometres	Length of road segment (feature) in kilometres
<b>Wildlife reserves.shp</b>	4	Boundaries of Malawi's four Wildlife Reserves	Area	Area of Wildlife Reserve (feature) in square metres
			Perimeter	Length of perimeter of Wildlife Reserve (feature) in metres
			Hectares	Area of Wildlife Reserve (feature) in hectares
			Km_sq	Area of Wildlife Reserve (feature) in square kilometres
			Wresname	Name of Wildlife Reserve

File Name	Number of Features	Description	Attribute Field Name	Attribute Description
<b>Vegetation.shp</b>	155	Boundaries of vegetation cover units for all of Malawi	Area	Area of vegetation unit (feature) in square metres
			Perimeter	Length of perimeter of vegetation unit (feature) in metres
			Hectares	Area of vegetation unit (feature) in hectares
			Sq_km	Area of vegetation unit (feature) in square kilometres
			Vcode	Vegetation category code, defined in "Legend" field
			Legend	1 = Montane evergreen forest
				2 = Montane grassland
				3 = Semi-evergreen forest
				4a = Closed-canopy woodland of wetter uplands
				4b = Open-canopy woodland of plateaux
				4c = Open-canopy woodland of hills and scarps
				4d = Open-canopy woodland of fertile areas
				5a = Mopane woodland
				5b = Woodlands of fertile areas
				5c = Thicket/Savanna of poorer areas
				5d = Woodland/Savanna (mixed species)
				6 = Sand dune vegetation
				7a = Woodlands of wet fringes (Terminalia Sericea)
<b>Utm grid.shp</b>	93	UTM grid covering Shire Valley	Length	Length of each section of grid (feature) in metres (50,000m)
			Utmgridlin	Metres east (E) of central meridian or north (N) of reference latitude
			Kilometres	Length of each section of grid (feature) in kilometres (50km)

## B. Tabular (Attribute) Database

**Description:** Agricultural production data for 13 different crops in 154 Extension Planning Areas (EPAs).

**Crops:**

1984 - 1998	1994 - 1998
Long Season Maize	Composite Maize
Hybrid Maize	Pulses
Cassava	Sorghum
Rice	Potato
Groundnuts	Sweet Potato
	Tobacco
	Millet
	Cotton

**Format:** 3 Microsoft Excel (xls) files  
EPAAREA.XLS – annual area planted to each crop (hectares)  
EPAYIELD.XLS – average yield of each crop (tonnes/hectare)  
EPAPROD.XLS – annual production (tonnes)

**Source:** FEWS, Lilongwe

### COMPASS Publications

Document Number	Title	Author(s)	Date
Document 1	COMPASS Year 1 Work Plan	COMPASS	Jul-99
Document 2	COMPASS Small Grants Management Manual	Umphawi, A., Clausen, R., Watson, A.	Sep-99
Document 3	Year 2 Annual Work Plan	COMPASS	Dec-99
Document 4	July 1 - September 30, 1999: Quarterly Report	COMPASS	Oct-99
Document 5	Training Needs Assessment: Responsive Modules & Training Approach	Mwakanema, G.	Nov-99
Document 6	Guidelines and Tools for Community-Based Monitoring	Svendsen, D.	Nov-99
Document 7	Policy Framework for CBNRM in Malawi: A Review of Laws, Policies and Practices	Trick, P.	Dec-99
Document 8	Performance Monitoring for COMPASS and for CBNRM in Malawi	Zador, M.	Feb-00
Document 9	October 1 - December 31, 1999: Quarterly Report	COMPASS	Jan-00
Document 10	Workshop on Principles and Approaches for CBNRM in Malawi: An assessment of needs for effective implementation of CBNRM	Watson, A.	Mar-00
Document 11	January 1 - March 31, 2000: Quarterly Report	COMPASS	Apr-00
Document 12	Thandizo la Ndalama za Kasamalidwe ka Zachilengedwe (Small Grants Manual in Chichewa)	Mphaka, P.	Apr-00
Document 13	Njira Zomwe Gulu Lingatsate Powunikira Limodzi Momwe Ntchito Ikuyendera (Guidelines and Tools for Community-based Monitoring in Chichewa)	Svendsen, D. - Translated by Mphaka, P. and Umphawi, A.	May-00
Document 14	Grass-roots Advocacy for Policy Reform: The Institutional Mechanisms, Sectoral Issues and Key Agenda Items	Lowore, J. and Wilson, J.	Jun-00
Document 15	A Strategic Framework for CBNRM Media Campaigns in Malawi	Sneed, T.	Jul-00
Document 16	Training Activities for Community-based Monitoring	Svendsen, D.	Jul-00
Document 17	April 1 - June 30, 2000: Quarterly Report	COMPASS	Jul-00
Document 18	Crocodile and Hippopotamus Management in the Lower Shire	Kaloweckamo, F.	Sep-00
Document 19	Cost-Sharing Principles and Guidelines for CBNRM Activities	Moyo, N.	Sep-00
Document 20	Workplan: 2001	COMPASS	Nov-00
Document 21	July 1 - September 30, 2000: Quarterly Report	COMPASS	Oct-00
Document 22	Opportunities for Sustainable Financing of CBNRM in Malawi: A	Watson, A.	Nov-00

	Discussion		
Document 23	Framework for Strategic Planning for CBNRM in Malawi	Simons, G.	Nov-00
Document 24	Kabuku Kakwandula Ndongomeko ya Thumba Lapadera la Wupu wa COMPASS (Chitumbuka version of the COMPASS Small-grant Manual)	Umphawi, A., Clausen, R. & Watson, A. Translated by Chirwa, T.H. & Kapila, M.	Dec-00
Document 25	COMPASS Performance and Impact: 1999/2000	COMPASS	Nov-00
Document 26	October 1 - December 31, 2000: Quarterly Report	COMPASS	Jan-01
Document 27	COMPASS Grantee Performance Report	Umphawi, A.	Mar-01
Document 28	January 1 - March 31, 2001: Quarterly Report	COMPASS	Apr-01
Document 29	Natural Resource Based Enterprises in Malawi: Study on the contribution of NRBs to economic development and community-based natural resource management in Machinga District	Lowore, J.	Apr-01
Document 30	Proceedings of the First National Conference on CBNRM in Malawi	Kapila, M., Shaba, T., Chadza, W., Yassin, B. and Mikuwa, M.	Jun-01
Document 31	Natural Resource Based Enterprises in Malawi: Action Plans	Watson, A.	Jun-01
Document 32	Examples of CBNRM Best Practices in Malawi	Moyo, N. & Epulani, F.	Jun-01
Document 33	Media Training for CBNRM Public Awareness	Kapila, M.	Jun-01
Document 34	April 1 - June 30, 2001: Quarterly Report	COMPASS	Jul-01
Document 35	Strategic Plan for CBNRM in Malawi	CBNRM Working Group	Sep-01
Document 36	Workplan: 2002	COMPASS	Oct-01
Document 37	July 1 - September 30, 2001: Quarterly Report	COMPASS	Oct-01
Document 38	COMPASS Performance and Impact: 2000/2001	COMPASS	Dec-01
Document 39	Coordination of CBNRM in Malawi: Financing Options	Watson, A.	Jan-02
Document 40	Performance Monitoring for CBNRM in Malawi	CBNRM Working Group	Oct-02
Document 41	October 1 – December 31, 2001: Quarterly Report	COMPASS	Jan-02
Document 42	COMPASS Field Level Training Impact Evaluation	Moyo, N.	Feb-02
Document 43	COMPASS Grantee Performance Report: 2001	Umphawi, U.	Apr-02
Document 44	COMPASS Assessment: 2001	Sambo, E., Carr, S., Omambia, D. & Moore, T.	Apr-02
Document 45	January 1 - March 31, 2002: Quarterly Report	COMPASS	Apr-02
Document 46	Community Tourism and Enterprise Training Manual	Kacal, S.	Jun-02
Document 47	Charcoal, Chiefs and Chambo: Status of CBNRM Policies in Malawi	Trick, P. & Manning, L.	Jun-02

Document 48	April 1 - June 30, 2002: Quarterly Report	COMPASS	Jul-02
Document 49	Business Development Services for Natural Resource Based Enterprises	Magai, G. & Nthambi, T.	Sep-02
Document 50	July 1 – September 30, 2002: Quarterly Report	COMPASS	Oct-02
Document 51	Workplan: 2003	COMPASS	Oct-02
Document 52	COMPASS Performance and Impact: 2001/2002	COMPASS	Oct-02
Internal Report 1	Building GIS Capabilities for the COMPASS Information System	Craven, D.	Nov-99
Internal Report 2	Reference Catalogue (2nd Edition)	COMPASS	Feb-01
Internal Report 3	Workshop on Strategic Planning for the Wildlife Society of Malawi	Quinlan, K.	Apr-00
Internal Report 4	Directory of CBNRM Organizations (2nd Edition)	COMPASS	Jan-01
Internal Report 5	Proceedings of Water Hyacinth Workshop for Mthunzi wa Malawi	Kapila, M. (editor)	Jun-00
Internal Report 6	COMPASS Grantee Performance Report	Umphawi, A.	Jun-00
Internal Report 7	Examples of CBNRM Best-Practices in Malawi	Moyo, N. and Epulani, F.	Jul-00
Internal Report 8	Software Application Training for COMPASS	Di Lorenzo, N.A.	Sep-00
Internal Report 9	Directory of COMPASS ListServ Members	Watson, A.	Jan-01
Internal Report 10	Introductory Training in Applications of Geographic Information Systems and Remote Sensing	Kapila, M.	Feb-01
Internal Report 11	COMPASS TAMIS Grants Manual	Exo, S.	Mar-01
Internal Report 12	Review of Recommendations of the Lake Chilwa and Mpoto Lagoon Fisheries By-Laws Review Meeting	Nyirenda, K.	May-01
Internal Report 13	End-of-Term Evaluation of the Co-Ordination Unit for the Rehabilitation of the Environment (CURE)	Sambo, E.Y.	Sep-01